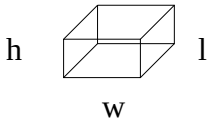
Physics 11 Laboratory Report Guidelines + Sample Lab on Precision

Purpose: A brief description of the relationship under investigation.
e.g. Measure the density of a material using a ruler, vernier caliper and a micrometer. Note the relative benefits of each device.

Theory/Hypothesis:
1) The hypothesis you are testing and state any assumptions you are making 2) the mathematical equations that you will use or test in the experiment 3) define any variables used 4) a diagram
e.g. The micrometer should give the most precise measurement of length and therefore density, while the ruler should give the least precise measurement. The accepted value for the density of copper is 8.95 g/cm^3 aluminum is 2.70 g/cm^3 and iron is 7.86 g/cm^3. Density, ρ, is the ratio of mass, m, divided by the volume, V or $\rho = m/V$. The Volume of a rectangular prism is determined using the formula V = lwh, where l is length, w is width, and h is height.



Materials and Procedure: A description of the materials and procedure used. **Do not** recopy the materials and procedure from the lab sheet. On your report state, "refer to physics 11 lab manual pages 14-17." List any changes made to the procedure.

Observations: All data collected is to be listed neatly in this section. Wherever possible, a table with a title should be used to record the observations. The title should explain the data. (therefore table 1 is **not** a good title) Original data must be included with the lab report. Include the uncertainty with each measurement. The uncertainty is half the smallest measuring unit on the device or the smallest and largest value the measurement could be.

Mass and Dimensions of a Metal

Measuring device	Mass min (g)	Mass Max (g)	Length, min (cm)	Length max (cm)	Width min (cm)	Width max (cm)	Height min (cm)	Height max (cm)
Ruler								
Vernier Caliper								
Micrometer			Too long Use ⇧	Too long Use ⇧				

Analysis: One sample calculation is required for each calculation done. Data should be graphed on a separate page and an equation relating the variables found. Calculations for the graph should be done directly on the graph.
Calculate the percentage error using the following equation:
percentage error = |experimental value-theoretical value|/theoretical value x 100%
The experimental value is what you measure and the theoretical value is the value predicted in the theory.
IB students or grade 12 students should calculate the uncertainty in the results and compare them to the percentage error.

e.g. Calculated Densities of a Metal

Measuring device	Volume min (cm^3)	Volume max (cm^3)	Density min (g/cm^3)	Density max (g/cm^3)	Density avg (g/cm^3)	%error (%)
Ruler						
Vernier Caliper						
Micrometer						
Sample calculation						

For ruler, V = lwh = 2.33 cm (2.21 cm) (1.23 cm) = 6.33 cm^3

ρ = m/V = 63.33 g/ 6.33 cm^3 = 10.0 g/cm^3

$\rho_{avg} = (\rho_{max} + \rho_{min})/2$ = (10.0 g/cm^3 + 8.4 g/cm^3)/2 = 9.2 g/cm^3

accepted value = 8.95 g/cm^3

% error = (exp – theo)/theo x 100% = (9.2 g/cm^3 –8.95 g/cm^3)/8.95 g/cm^3 x 100% = 3 %

(IB only) % uncertainty for Ruler ={(0.1/2.33) + (0.1/2.21) + (0.1/1.23)}x 100% = 18 %

or, using max/min values, = (10.0 g/cm^3 – 8.4 g/cm^3)/10.0 g/cm^3 x 100% = 16 %

Discussion: Answer any assigned questions.

Results and Conclusion: A summary of the results of the experiment and a statement relating the results to the theory. Give the percentage error for the result. Ask yourself, "Does this data demonstrate the relationship predicted in the theory?"

e.g. The micrometer produced the smallest range of values for density, only 0.05 g/cm^3 difference between max and min, compared to the vernier caliper 0.1 g/cm^3 and the ruler 1 g/cm^3. This supports my hypothesis that the micrometer is the most precise and the ruler the least precise instrument. The density for copper measured using the vernier caliper was 8% off the accepted value, which is much larger than the expected % difference given a 0.1 g/cm^3 range between max and min. Since the measurements of the caliper are off by roughly 8% while the other instruments are within the uncertainty range, this would lead to the conclusion that the particular vernier caliper used is inaccurate.

Sources of Uncertainty: An analysis of aspects of the materials and procedure which are likely to have influenced the precision and accuracy of the data. Be sure to describe how they influence the data and what evidence you have to support your analysis. Ask yourself the question, "What factors account for the shape of the graph and the size of the percentage error?" Distinguish between random and systematic errors. How could you improve the experiment?

e.g. Since all the lengths measured by the caliper are larger than other devices, this is a systematic error. This could be a result of a bend in the caliper. The rest of the % error values are within the expected random errors that are due to the precision of the measuring device. If I were to repeat the experiment with another vernier caliper, I could determine if the particular vernier caliper was faulty or my use of the device. Multiple measurements with various rulers, vernier calipers and micrometers would alleviate any concern about the particular condition of the specific device. Since the measurements using the micrometer and ruler are within uncertainties, the error is not a result of impurities in the material, curved edges or other such factor.